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ABSTRACT

This study focuses on student concept changes in acids and bases. Variables include field dependent level, personal independence level, interest in science or chemistry, teaching strategy, and student gender. This study of Grade 10 students (N=81) provides information relevant to secondary school chemistry learning, teaching, and concept change. Results suggest that different field dependent levels do not significantly influence student concept changes, personal independent level does not significantly influence student concept change, student gender also does not significantly influence student concept change except in the area of ionization, and the lecture group in this study showed more improved concept changes in acids and bases than the laboratory group. (Author/DDR)

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Student Concept Changes in Acids and Bases

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Purpose of Study

This study focuses on student concept changes in acids and bases. The variables: **F**ield **D**ependent Level (FD), **P**ersonal **I**ndependent Level (PI), **I**nterest in **S**cience or Chemistry (IS), **T**eaching **S**trategy (TS), and **S**tudent **G**ender (SG) were analyzed to determine their effect on student concept change. The FD, PI, and IS are new study variables in this research field. The study provides information relevant to secondary school chemistry learning, teaching, and concept change.

Research Method

Subjects:

Eighty-one tenth grade students, enrolled in a high school in northwestern Texas, were tested. The sample included 36 females, and 45 males.

Instruments and Procedures:

The Standard test Group Embedded Figures Test (GEFT) was used to determine student Field Dependent Level (FD). A questionnaire was developed to test student Personal Independent Level (PI, 7 questions) and Interest in Science (IS, 5 questions).

The study processes were:

- Test student **P**ersonal **I**ndependent Level (PI), **I**nterest in **S**cience (IS), and **F**ield **D**ependent Level (FD)
- Pretest student concepts with 10 questions in acids and bases
- Conduct two different **T**eaching **S**trategies (TS)
- Posttest student concepts with questions similar to the pretest.

Data Analysis:

Multiple Linear Regression was used to analyze which variables significantly influenced student concept changes.

ANOVA was used to compare student concept changes by different variables.

Explanation of Terms:

Field-dependent and field-independent learners: "Field-dependence/independence is one of the most commonly employed measures of cognitive style. It is a measure of how well a learner can restructure a representation of knowledge based on the use of salient cues and field arrangement. Research (Witkin, Moore, Goodenough, and Cox, 1977) has indicated that field-dependent learners are less likely to impose a meaningful organization on a field that lacks structure and are less able to learn conceptual material when cues are not available" (p. 452). (Weller, H. G. (1995). Computers in human behavior.)

Group Embedded Figures Test (GEFT): Published by Consulting Psychologists Press (1971) as a measure of cognitive style. "On the GEFT, each student is allowed a limited amount of time to locate and trace simple figures hidden within complex figures. The range of possible scores is 0-18, with the higher scores indicating a greater degree of field-dependence" (p. 454-5). This test has a reliability coefficient of 0.82. (Weller, H. G. (1995). Computers in human behavior.)

Personal Independent Level (PI): A person who trusts their own knowledge, over that of an authority such as a teacher or textbook, exhibits a high level of personal independence. Established with a Likert scale questionnaire developed by the authors.

Discussion

Students may memorize science vocabulary, facts, and formulas, yet fail to master important science concepts. There is, very often, little understanding behind the facade of stored factual knowledge. While factual knowledge about science is relatively easy to teach and test, it is much more difficult to achieve an understanding of science concepts.

Students frequently hold erroneous ideas about science phenomena and concepts. Research indicates that students do not switch easily from their old pre-instructional concepts to the new science concepts taught. There are two broad reasons for this:

- Students are usually quite satisfied with their own concepts, and do not see the value of new science ideas.
- Students often learn the factual knowledge presented, and tested for on multiple choice exams, without developing an understanding of the underlying concepts.

Many studies have been conducted concerning student concept changes in meta-knowledge, the learning process, instructional goals, teaching models, and the role of the teacher. In this study, we explored five variables for student concept changes in acids and bases.

Of the five variables examined, the following are new to this research area in influencing concept change:

- field independent level,
- personal independent level, and
- student interest in science.

In this study, student responses to the ten pretest and ten similar posttest questions, were classified into eight areas: define, symbol, feel, taste, react, ionize, classify, and formula.

Two of the eight areas, symbol and formula, were found to have shown decreased student understanding on the posttest as compared to the pretest. An examination of those questions will attempt to explain this apparent discrepancy.

Pretest question #2: Which symbol represents a proton?

a) H^+ b) H^- c) H_2O d) OH^-

The correct response is: a) H^+.

Posttest question #2: Which symbol represents a hydronium ion?

a) H^+ b) H^- c) H_3O^+ d) OH^-

The correct response is: c) H_3O^+.

It may be that the students were familiar with a proton being represented as H^+. But even after instruction, they had apparently not grasped the fact that the hydronium ion is represented as H_3O^+.

The "formula" area questions were:

Pretest: The formulas for the most common organic acids end in _____.

a) COOH b) Cl c) NH_2 d) H_2O

The correct response is: a) COOH

Posttest: The formulas for the most common organic bases end in _____.

a) COOH b) Cl c) NH_2 d) H_2O

The correct response is: c) NH_2

Some students may have been familiar with the fact that organic compounds contain carbon. Therefore, they selected the only formula, in both questions, which had a "C". That would have produced a correct response on the pretest, but incorrect on the posttest.

Results and Conclusions

Different Field Dependent levels (FD) do not influence student concept changes significantly (figure 1).

Different Science Interest levels (SI) influence student concept changes in the areas of "classify" and "formula" – students with higher science interest improve their concepts in these two areas more than low interest students (figure 2).

Personal Independent level (PI) does not significantly influence student concept change (figure 3).

Student gender also does not significantly influence student concept change, except for the "ionize" area (figure 4).

In our study, the lecture group showed more improved concept changes, in acids and bases, than the laboratory group (figure 5). However, we suggest that further studies add a third group that uses both the lecture and laboratory methods, in combination.

Figures

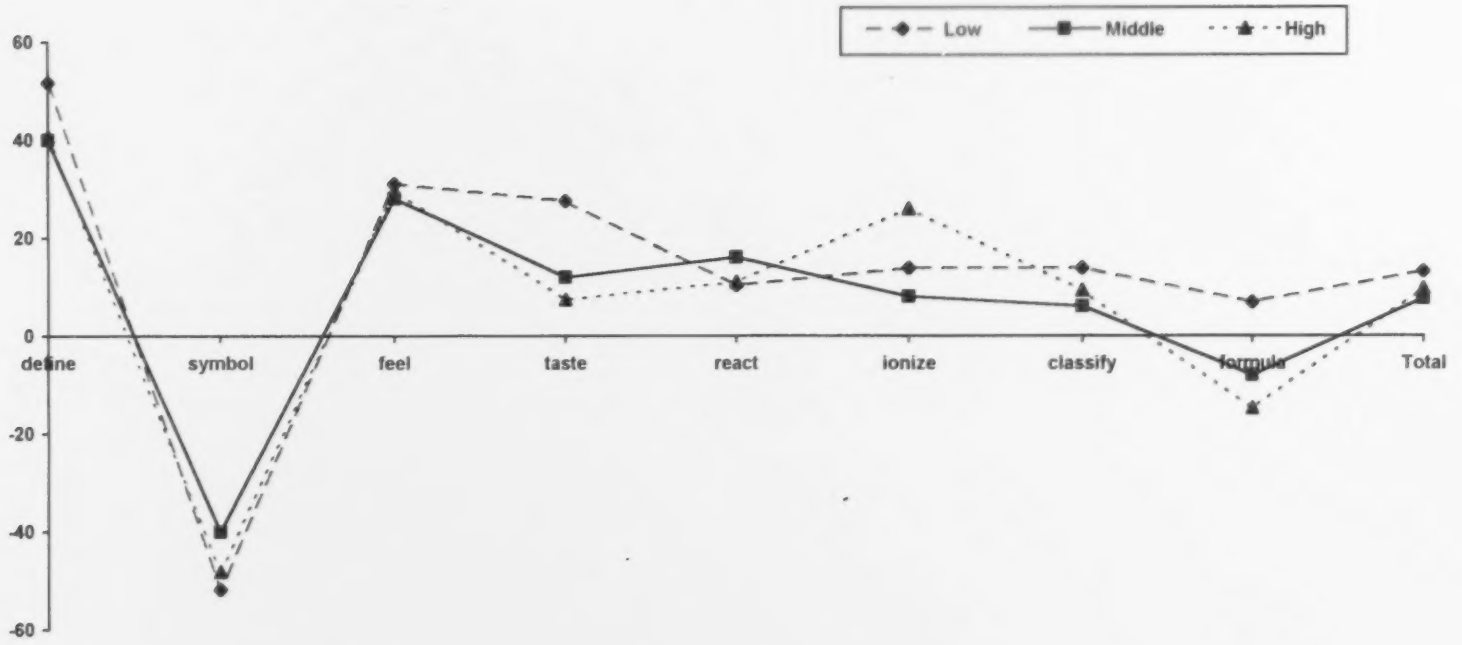

Figure 1. Comparison of Student Concept Changes by Field Dependent Level

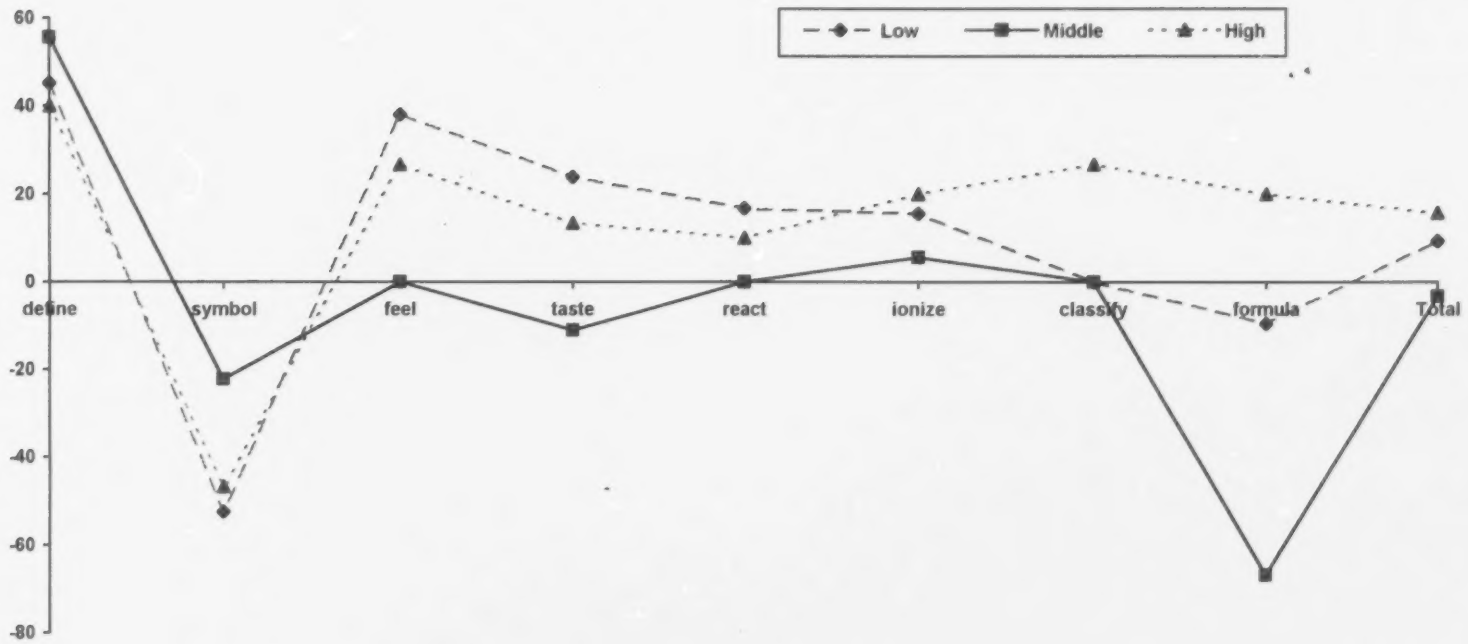

Figure 2. Comparison of Student Concept Changes by Science Interest Level

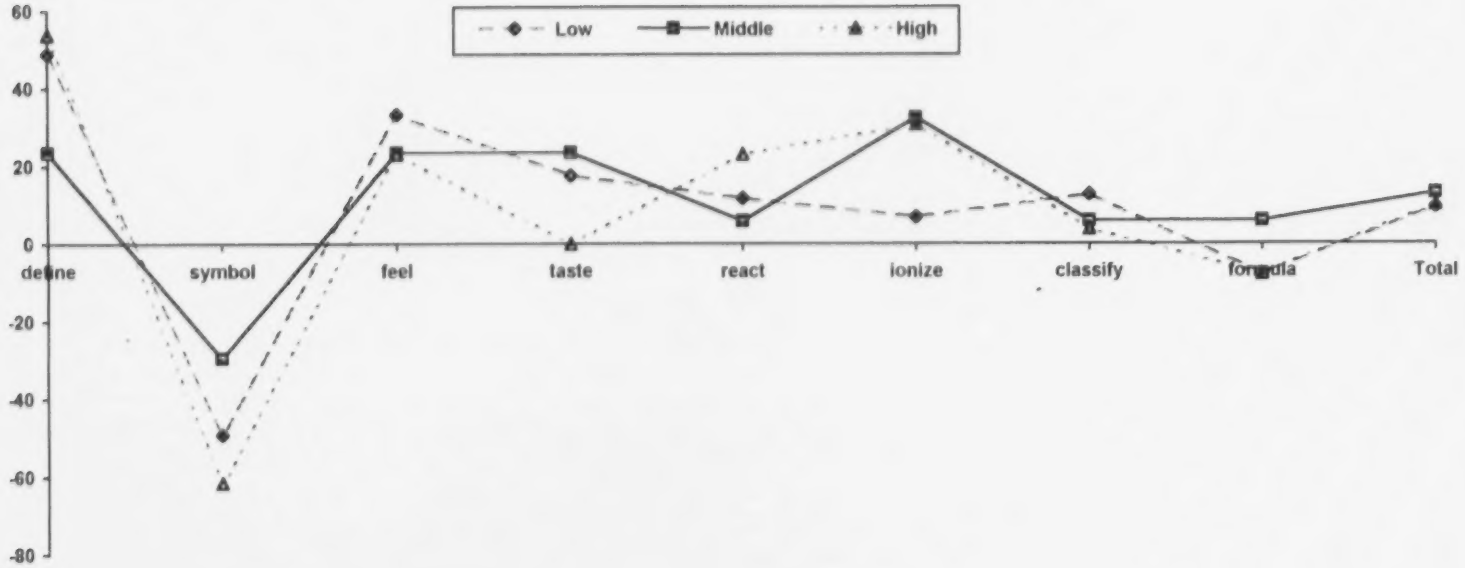

Figure 3. Comparison of Student Concept Changes by Personal Independent Level

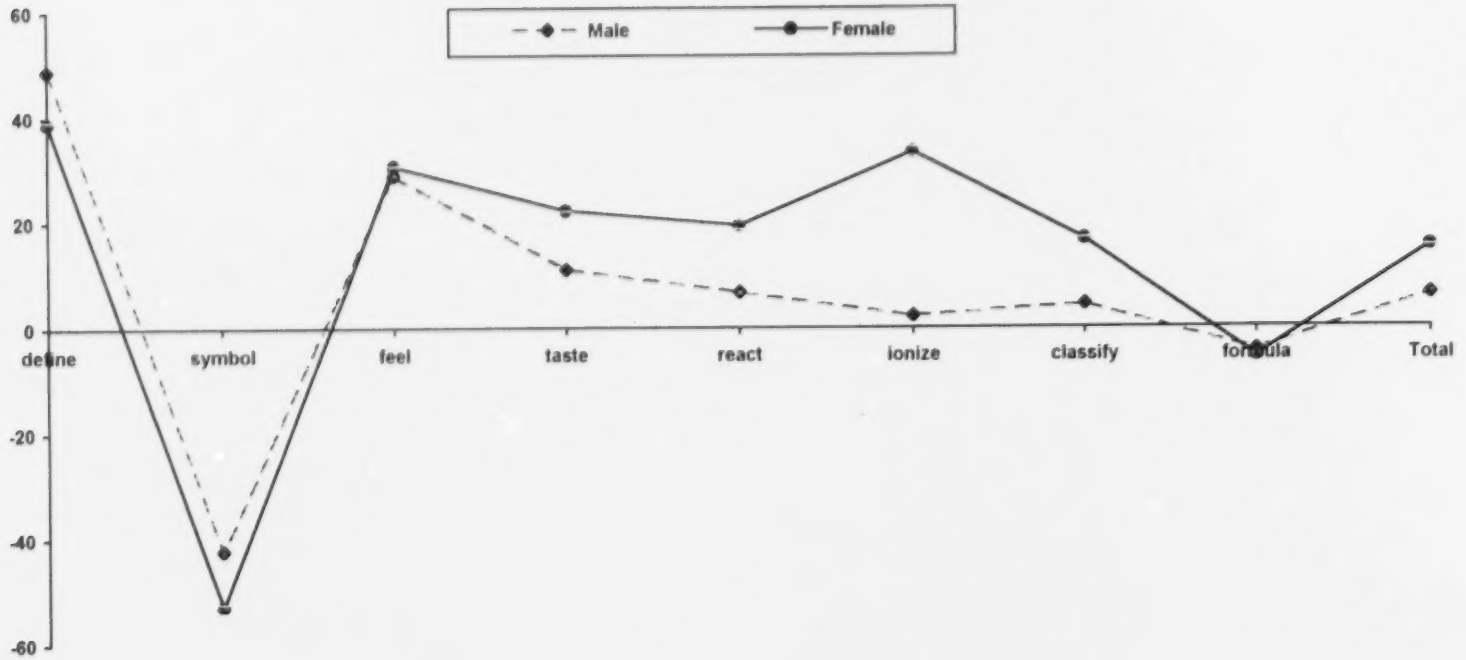

Figure 4. Comparison of Student Concept Changes by Gender

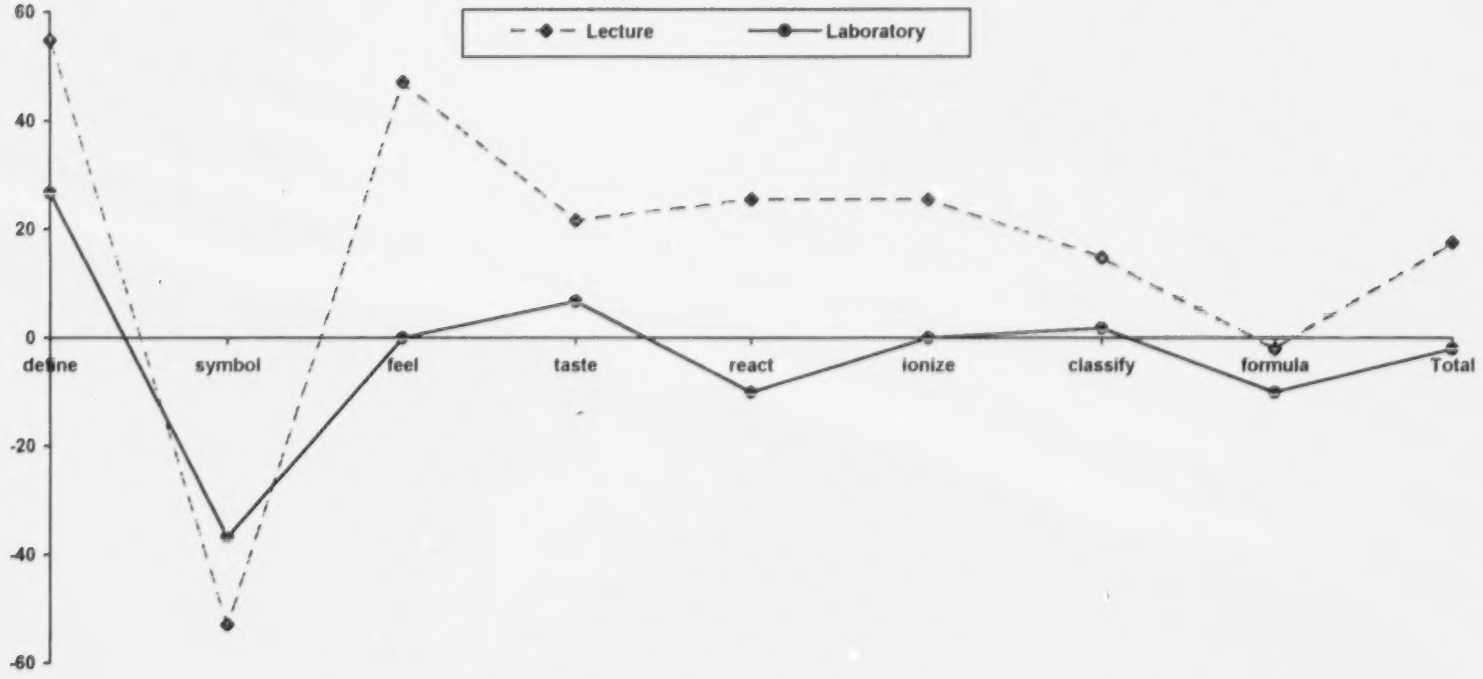

Figure 5. Comparison of Student Concept Changes by Learning Method

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Appendix

Name:_____ Chemistry 1, Period _____

Date:_____

CHEMISTRY PRETEST
ACIDS AND BASES

Write the letter for the correct answers in the spaces before the questions.

_____ 1. An acid can be defined as a substance that _____ a proton.
a) has b) lacks c) accepts d) donates

_____ 2. Which symbol represents a proton?
a) H^+ b) H^- c) H_2O d) OH^-

_____ 3. A base feels _____?
a) hot b) cold c) sticky d) slippery

_____ 4. Acids taste _____.
a) flat b) sharp c) salty d) sweet

_____ 5. An Arrhenius acid and base will react to form a _____ and water.
a) metal b) nonmetal c) salt d) strong acid

_____ 6. A weak acid ionizes _____.
a) completely b) slightly c) not at all d) at boiling

_____ 7. A weak base ionizes _____.
a) completely b) slightly c) not at all d) at boiling

_____ 8. Which of these is an acid?
a) baking soda b) NaCl c) soap d) vinegar

_____ 9. Which of these is a base?
a) H_2CO_3 b) NaCl c) soap d) vinegar

_____ 10. The formulas for the most common organic acids end in _____.
a) COOH b) Cl c) NH_2 d) H_2O

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Name:_____ Chemistry 1, Period _____

Date:_____

CHEMISTRY POSTTEST
ACIDS AND BASES

Write the letter for the correct answers in the spaces before the questions.

_____ 1. An base can be defined as a substance that _____ a proton.
a) has b) lacks c) accepts d) donates

_____ 2. Which symbol represents a hydronium ion?
a) H^+ b) H^- c) H_3O^+ d) OH^-

_____ 3. A base feels _____.
a) hot b) cold c) sticky d) slick

_____ 4. Acids taste _____.
a) flat b) sour c) salty d) sweet

_____ 5. An Arrhenius acid and base will react to form a _____ and water.
a) metal b) nonmetal c) salt d) strong acid

_____ 6. A strong acid ionizes _____.
a) completely b) slightly c) not at all d) at boiling

_____ 7. A weak base ionizes _____.
a) completely b) slightly c) not at all d) at boiling

_____ 8. Which of these is an acid?
a) baking soda b) NaCl c) soap d) orange juice

_____ 9. Which of these is a base?
a) H_2CO_3 b) NaCl c) soap d) orange juice

_____ 10. The formulas for the most common organic bases end in _____.
a) COOH b) Cl c) NH_2 d) H_2O